said angle between said predominant fiber orientation and the longer side of said panel being between about 55-75°; and

approximately one-half of said reinforcing layers of said panel forming a + angle between about 55-75°, and approximately one-half of said reinforcing layers forming a - angle between about 55-75°, with respect to said longer side of said panel, wherein said panel, when mounted in said vessel wall, is laterally loaded by fluid pressure.

REMARKS

Reconsideration of this application is respectfully requested. This amendment after final Action should be entered because it overcomes a minor matter of form and clearly places the claim in better condition for allowance or appeal.

The rejection of claims 10-23 under 35 U.S.C. §112, second paragraph, is traversed. The term "laminated" in claim 10 is not indefinite. The term "laminated" is defined in a general dictionary as "composed of layers of firmly united material". Webster's Third New International Dictionary, p. 1, 2, 67 (attached). The term "laminate" is defined in a technical dictionary as "a sheet of material made of several different bonded layers". McGraw-Hill Dictionary of Scientific and Technical Terms, p. 1104 (attached). Similarly, "laminate" is defined in a technical reference as "[t]o unite laminate with a bonding material, usually with pressure and heat." Composites, ENGINEERED MATERIALS HANDBOOK, vol. 1, p. 14 (attached). Further, the term "bonding" (used to define "laminate") is defined as "fastening together of two

components of a device by means of adhesives, as in anchoring the copper foil of printed wiring to an insulated base board". McGraw-Hill Dictionary of Scientific and Technical Terms, p. 251 (attached). Accordingly, in the context of panels formed of fiber materials, the term "laminate" requires the use of a bonding agent, e.g. a resin, to firmly secure two or more layers of the fiber material together as a united panel.

Stitching of fiber materials does not constitute lamination. Stitching does not fasten layers together by bonding (see McGraw-Hill and Engr. Mat. Hndbk. definitions) and does not "firmly" unite layers (see Webster's definition). Stitching two fiber panels together may be useful in aligning the panels together before they are laminated, i.e. bonded, together. While stitching two fiber panels together may be used as a preliminary step, the fiber layers are bonded together to be laminated.

The claims have been amended to make clear that the laminate layers are "bonded" by the amendment above to independent claim 10. By amending claim 10 to require the laminate layers to be "bonded", the claims recite what is inherently a property of "laminated layers" (and thus do not inject new matter) and to more clearly distinguish panels which are attached together by no more than stitching, as is described in Harpell. Accordingly, the indefinite rejection should be withdrawn.

The rejection of claims 10-23 as being obvious over Harpell et al (U.S. Patent No. 5,198,280) is traversed. The claims have been amended to recite the panel as a "plastic plate" having laminated layers that are "bonded together". Support in the specification for the claim amendment is provided at page 1, line 9 ("laterally pressure-loaded reinforced plastic plate"). Accordingly, claim 10 recites a panel, for a vessel, comprising

a plastic plate having at least two reinforced laminated layers that are bonded together, wherein each layer has substantially parallel fibers. The angle between the fiber orientations of the laminated layers is a narrow angle between 55° to 75° degrees. Claim 10 also recites that the panel is mounted in a vessel wall. The teaching in Harpell of a flexible bullet proof vest with layers of fiber stitched together would not have rendered obvious the claimed invention.

Harpell discloses fabric for a bulletproof vest. Harpell identifies as prior art many different applications of high strength fibers, but the disclosed material is a material having "flexible fibrous layers" for a bullet proof body armor. Further, the Action applies the flexible fibrous layers as prior art to support its rejection, and not the generic description of applications for high strength fibers in the prior art section of Harpell. There is no teaching or suggestion in Harpell that the "flexible fibrous layers" are useful as a structural member, such as a vehicle panel. It is improper to apply the flexible bulletproof fabric disclosed in Harpell as teaching the panel recited in independent claim 10. To make this distinction clear, claim 10 states that the recited panel is for a vessel wall, that the panel is "a plastic plate", and that the panel when mounted in the vessel wall is "laterally loaded by fluid pressure". The Harpell flexible layers are not for a vessel, do not form a plastic plate, and would not withstand lateral loading by a fluid.

The passage on column 1 of Harpell, does not suggest the use of the Harpell stitched fabric as in panels of a vessel wall. The cited passage in Harpell merely tells that on use of high strength fibers is in vehicle panels. Harpell does not describe a generic application of high strength fibers, but is specifically directed to fabrics formed of high

strength fibers. Harpell does not say that the flexible fiber structure disclosed therein should be used as a vehicle panel or, as a plastic plate, or to be laterally loaded by fluid pressure. Indeed, the flexible body armor fabric disclosed in Harpell is not applicable as a structural panel of a vehicle.

Harpell's stitched layers are not bonded together by means of bonding the layers to form a laminated panel. As stitching is one way of securing the layers of the Harpell fabric, it is easy to understand that the end product is a flexible garment and not a plastic plate for a vessel wall. While Harpell uses the word "laminate" at columns 4 and 5 for the disclosed flexible armor layers, there is no suggestion that the layers are bonded into a plastic plate panels for use as boat hulls or other vessel walls.

Harpell teaches on column 10 (lns. 55-56) that the desired flexibility may vary, makes clear that the product is planned to be flexible. Harpell does not suggest that the fiber layers should be bonded to form a rigid panel for a vessel wall.

The layers forming the panel in the claimed invention are "laminated" as independent claim 10 has been amended. By requiring the layers to be laminated, the claimed invention is further distinguished from the multi-layer fabric disclosed in Harpell. The various layers in Harpell are stitched together to maintain flexibility of the fabric. See e.g., Harpell, col. 10, ln. 57 and col. 12, lns. 11-48, and col. 13, lns. 36 et seq. The flexibility of the Harpell fabric precludes the layers of the fabric from being "firmly united" and, thus, Harpell does not disclose laminated layers as recited in claim 10.

Harpell at column 4 teaches that the angle between the fiber orientations of adjacent fiber layers is 45° to 90°. In the present invention, the corresponding angle is

between 30° to 70°. The Harpell specification also teaches that the most preferred angle would be 90°, e.g. far from the range stated in this application. Furthermore, Applicants submitted evidence that establishes that the fiber orientation angles are optimum between 30° to 70°. Accordingly, Harpell does not teach the optimal fiber orientations that are claimed here.

As stated in the Action, Harpell does not teach the side aspect ratio of the panel recited in claim 10. Harpell also does not teach the narrow range of ± 55-75° angle between the fibers and the long side of the panel. Rather, Harpell teaches that the fibers of each fabric layer are preferably oriented at 45°. Harpell teaches away from the narrow range of angular offset, i.e., between 55° to 75° which is recited in the claims. If Harpell cannot angularly offsets the fabric layers by 55-75° with respect to a side of the fabric panel and at the same time has the fibers rotated by 45° with each layer. Accordingly, it would not have been obvious to rotate the fabric fiber orientation by 55-75° between each fabric layer in Harpell.

The offset angle range of ± 55-75° recited in claim 10 has been demonstrated to provide unexpected and significant benefits, as shown by the test results shown in Figures 3 to 6. Figure 4, for example, shows that by orienting the fibers at an angle between 55-75° with respect to the long side of an elongated panel, superior deflection resistance and failure reduction occur. Harpell provides no suggestion that superior deflection and failure characteristics are obtained when fibers are oriented at 55-75° with respect to a long side of a panel.

Because Harpell does not teach or suggest a laminated panel for a vessel, a panel having a long side to short side ratio of at least 1.5, or a fiber angle with respect to the long side of 55-75° in each layer of the laminate panel, there is no obviousness.

This application is in good condition for allowance. If any small matter remains outstanding, the Examiner is requested to telephone applicants' attorney. Prompt reconsideration and allowance of this application is respectfully requested.

Attached hereto is a marked-up version of the changes made to the specification and claim(s) by the current amendment. The attached page(s) is captioned "**Version With Markings To Show Changes Made.**"

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS

10. (Twice Amended) A panel for a vessel wall having a longer side and a shorter side, and a side aspect ratio of at least 1.5, and comprising:

a plastic plate having at least two reinforcing laminated layers bonded together of substantially unidirectional substantially parallel fibers having predominant orientations that form an angle with said sides of said panel;

said angle between said predominant fiber orientation and the longer side of said panel being between about 55-75°; and

approximately one-half of said reinforcing layers of said panel forming a + angle between about 55-75°, and approximately one-half of said reinforcing layers forming a - angle between about 55-75°, with respect to said longer side of said panel, wherein said panel, when mounted in said vessel wall, is laterally loaded by fluid pressure.

Attachment

Webster's Third New International Dictionary

OF THE ENGLISH LANGUAGE

UNABRIDGED

duced by intermittent deposit **b** : a thin layer between cleavage planes in slate or schist **4** : a plane section of a body having infinitesimal thickness

lamina cri·bro·sa \-krə'brōsə\ *n, pl* **laminae cribro·sae** \-,sē, -,sī\ [NL, lit., [illegible]se lamina] : any of several anatomical structures having the form of a perforated plate: as **a** : the cribriform plate of the ethmoid bone **b** : the part of the scleroid coat of the eye penetrated by the fibers of the optic nerve **c** : a perforated plate that closes the internal auditory meatus

lam·i·na·gram *or* **lam·i·no·gram** \'laməna,gram\ *n* [NL *lamina* or E *lamin-* + *-gram*] : a roentgenogram of a layer of the body made by means of a laminagraph

lam·i·na·graph *or* **lam·i·no·graph** \-raf, -räf\ *n* [NL *lamina* or E *lamin-* + *-graph*] : an X-ray machine that makes roentgenography of body tissue possible at any desired depth — **lam·i·na·graph·ic** *or* **lam·i·no·graph·ic** \,‥'grafik\ *adj* — **lam·i·nag·ra·phy** \,‥'nagrəfē\ *or* **lam·i·nog·ra·phy** \-'nägrə-\ *n* -ES

lam·i·nal \'lamən°l\ *adj* [*lamin-* + *-al*] **1** : LAMINAR **2** : produced with the participation of the front upper surface of the tongue (as \sh\, \zh\, \ch\, \j\, \y\)

lamina pro·pria \-'prōprēə\ *n, pl* **laminae propri·ae** \-rē,ē, -rē,ī\ [NL, lit., one's own lamina] : a highly vascular layer of connective tissue under the basement membrane lining a layer of epithelium

lam·i·nar \'laməna(r)\ *adj* [*lamin-* + *-ar*] **1** : arranged in, consisting of, or like laminae ⟨cut felt parts exhibit no tendency to separate into layers, despite the ~ formation of the batt from which the material was fabricated —*Story of Felt*⟩ **2** : of, relating to, or being a streamline flow ⟨the ~ motion of a fluid about a sphere —J.K.Vennard⟩

laminar flow *n* : streamline flow in a viscous fluid near a solid boundary — contrasted with *turbulent flow*

lam·i·nar·ia \,lamə'na(a)rēə\ *n* [NL, fr. *lamin-* + *-aria*] **1** *cap* : the type genus of the family Laminariaceae comprising chiefly perennial kelps with an unbranched cylindrical or flattened stipe and a smooth or convoluted blade that is either simple or deeply incised into segments **2** -s : any kelp of the genus *Laminaria*; *broadly* : any kelp of the order Laminariales — **lam·i·nar·i·oid** \,‥'‥,ȯid\ *adj*

lam·i·nar·i·a·ce·ae \,‥,‥'āsē,ē\ *n pl, cap* [NL, fr. *Laminaria*, type genus + *-aceae*] : a large family of kelps (order Laminariales) that includes many large kelps chiefly of northern waters and in some classifications is considered coextensive with the order — **lam·i·nar·i·a·ceous** \,‥,‥'āshəs\ *adj*

lam·i·nar·i·a·les \,‥,‥'ā(,)lēz\ *n pl, cap* [NL, fr. *Laminaria* + *-ales*] : an order of marine brown algae that include many economically important kelps, are largely restricted to cold or polar seas, are distinguished by a complex and often very large sporophyte which is usu. differentiated into well-defined holdfast, stipe, and blade, and have microscopic gametophytes

lam·i·nar·i·an \,‥'na(a)rēən\ *adj* [NL *Laminaria* + E *-an*] : of, relating to, or characterized by the presence of kelps of the genus *Laminaria*

lam·i·nar·in \,‥'na(a)rən\ *n* -s [ISV *laminar-* (fr. NL *Laminaria*) + *-in*] : a polysaccharide found in various brown algae that like starch yields only glucose on hydrolysis but differs from starch in molecular structure and properties

lam·i·narite \'laməna,rīt, ,‥'na(a),r-\ *n* -s [NL *Laminaria* + E *-ite*] : a fossil plant that is supposedly a seaweed related to the kelps of the genus *Laminaria*

lam·i·nary \'laməˌnerē\ *adj* [*lamin-* + *-ary*] : LAMINAR

¹lam·i·nate \-ˌnāt, *usu* -ād·+V\ *vb* -ED/-ING/-S [*lamina* + *-ate* (v. suffix)] *vt* **1** : to roll or compress (as metal or plastic) into a thin plate **2** : to separate into laminae **3 a** : to make by uniting superposed layers of one or more materials (as by means of an adhesive or bolts) — compare LAMINATED GLASS, LAMINATED PLASTIC, LAMINATED WOOD **b** : to unite (superposed layers of material) by an adhesive or other means ⟨asphalt is used to ~ sheets of paper —*Science*⟩ ⟨polyethylene film has been *laminated* to paper for waterproof bags —*Chem. & Engineering News*⟩ ~ *vi* : to divide into laminae

²lam·i·nate \-ˌnə̇t, -ˌnā|, *usu* |d·+V\ *adj* [*lamina* + *-ate* (adj. suffix)] **1** : consisting of a lamina or laminae : LAMINATED **2** : bearing or covered with laminae

³laminate \"\ *n* -s [*¹laminate*] : a product made by laminating; *specif* : LAMINATED PLASTIC

lam·i·nat·ed \-ˌnād·əd, -ātə̇d\ *adj* [*lamina* + *-ate* + *-ed*] **1** : LAMINATE 1 ⟨shale is ~ clay —*Chem. Industries*⟩ ⟨chocolate cake ~ in very fine layers with a light creamy paste between —Edmund Wilson⟩ **2** [fr. past part. of *¹laminate*] : made by laminating : composed of layers of firmly united material ⟨glued ~ arches are ideal for many kinds of buildings —*Architectural Record*⟩

laminated glass *n* : plate consisting of two or more sheets of glass with plastic sheeting bonded between to resist shattering — called also *safety glass, shatterproof glass*

laminated plastic *n* : a plastic made of superposed layers of paper, wood, or fabric bonded or impregnated with resin and compressed under heat

laminated spring *n* : LEAF SPRING

laminated wood *n* : layers of wood glued or otherwise united with the grains parallel to form boards or timbers — compare PLYWOOD

lam·i·na·tion \,laməˈnāshən\ *n* -s **1 a** : the process of laminating **b** : the quality or state of being laminated **c** : a laminated structure **d** : LAMINA — compare STRATIFICATION **2** : a crack parallel to the principal surfaces of sheet metal **3** *or* **la·mi·a·tion** \,lāmēˈāshən\ : a single stratum of a stratified ecological community

lam·i·na·tor \'laməˌnād·ə(r), -ātə-\ *n* -s : one that laminates; *esp* : one that makes a laminated plastic

lam·in·board \'laməˌn,ȯ\ *n* [*lamin-* + *board*] : a veneered wood consisting of a core of parallel sheets cemented together and faced with plies with the grain of the latter usu. at right angles to that of the core

lam·i·nec·to·my \,laməˈnektəmē\ *n* -ES [ISV *lamin-* + *-ectomy*] : surgical removal of the posterior arch of a vertebra

laming *pres part of* LAME

laminic — see LAMIN-

: lands or meadows held in severalty during the crop-raising period but subject to rights of common at other times (as for pasturage)

lammas shoot *often cap L* : a young leafy shoot produced usu. in late s[illegible]er by a woody plant (as an oak) from a bud that would n[illegible]ally open the following spring

lammed *past of* LAM

lam·mer \'lamər\ *n* -s [ME (northern dial.) *lambre, laumbre*, fr. MF *l'ambre* the amber, fr. *l'*, *le* the + *ambre* amber, ambergris — more at AMBER] *chiefly Scot* : AMBER

lam·mer·gei·er *or* **lam·mer·gey·er** *also* **lam·mer·geir** *or* **laem·mer·gei·er** \'lamə(r),gī(ə)r, 'lem-\ *n* -s [G *lämmergeier*, fr. *lämmer* (pl. of *lamm* lamb, fr. OHG *lamb*) + *geier* vulture, fr. OHG *gir* — more at LAMB, GIER-EAGLE] : the largest European bird of prey (*Gypaetus barbatus aureus*) indigenous to mountain regions from the Pyrenees to northern China, having a length of about 3½ feet and often a wingspread of nearly 10 feet, and resembling both the eagles and the vultures — called also *bearded vulture*

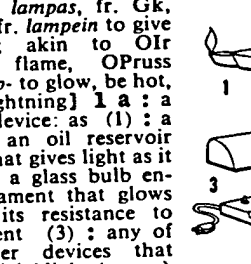
lamming *pres part of* LAM

lam·na \'lamnə\ *n, cap* [NL, fr. Gk, a shark, prob. alter. of *lamia* devouring monster (or, a shark) — more at LEMUR] : the type genus of the family Lamnidae comprising the porbeagle and a few related forms

lam·ni·dae \-nə,dē\ *n pl, cap* [NL, fr. *Lamna*, type genus + *-idae*] : a family of large fierce pelagic sharks including the porbeagle and related forms — see MACKEREL SHARK — **lamnoid** \-ˌnȯid\ *adj or n*

la·mo·na \lə'mōnə\ *n* [prob. fr. *Lamona*, Wash.] **1** *usu cap* : an American breed of white, short-legged domestic fowls **2** -s *often cap* : any bird of the Lamona breed

¹lamp \'lamp, -aa(ə)-, -ai-\ *n* -s [ME *lampe, lamp*, fr. OF *lampe*, fr. L *lampas*, fr. Gk, torch, lamp, fr. *lampein* to give light, shine; akin to OIr *lassaim* I flame, OPruss *lopis*, Hitt *lap-* to glow, be hot, ON *leiptr* lightning] **1 a** : a light-giving device: as (1) : a device with an oil reservoir and a wick that gives light as it burns (2) : a glass bulb enclosing a filament that glows because of its resistance to electric current (3) : any of various other devices that produce artificial light ⟨gas ~⟩ ⟨acetylene ~⟩ ⟨fluorescent ~⟩ **b** : a source of natural light (as the sun, the moon, or a star) ⟨the ~s of heaven⟩ **c** : any of various devices for the application of heat: as (1) : an apparatus for drying foundry molds during their fabrication (2) : a therapeutic heat lamp **2** : a source of intellectual, moral, or spiritual illumination ⟨thy word is a ~ to my feet and a light to my path —Ps 119: 105 (RSV)⟩ ⟨wanted them to be ~s unto themselves —Emma Hawkridge⟩ **3** : EYE ⟨my wasting ~s —Shak.⟩ ⟨turned her hot ~s on me —R.P.Warren⟩ — **of the lamp** *adv (or adj)* : of laborious study or excogitation : of strain or effort : without spontaneity, inspiration, or reality ⟨refined or artificial, smelling a little *of the lamp* —B.N.Cardozo⟩ ⟨a theory born *of the lamp* —Russell Lord⟩



lamps 1a: *1* ancient oil lamp, *2* kerosene lamp, *3* electric desk lamp

²lamp \"\ *vb* -ED/-ING/-S *vt* **1** *archaic* : to furnish with lamps **2** : to light or brighten by or as if by lamps ⟨scattered lights ~*ing* the rush and roll of the abyss —Robert Browning⟩ **3** *slang* : to look at : EYE, SEE ⟨I've ~*ed* two dicks — had their eye on us all day —Elmer Davis⟩ ⟨for the love of Patrick Henry, ~ that! —*Cosmopolitan*⟩ ~ *vi* : to shine as or like a lamp ⟨the Spirit-Seven companioning God's throne they ~ before —Robert Browning⟩

³lamp \"\ *vi* -ED/-ING/-S [prob. of imit. origin] *chiefly Scot* : to walk quickly taking long strides

lam·pad \'lamˌpad\ *n* -S [L *lampad-, lampas* — more at LAMP] : LAMP, CANDLESTICK — used of the seven lamps of fire in Rev 4:5 ⟨till wheeling round the throne the ~s seven (the mystic words of heaven) permissive signal make —S.T.Coleridge⟩

lam·pa·dite \'lampəˌdīt\ *n* -s [F, fr. Wilhelm A. *Lampadius* †1842 Ger. chemist + F *-ite*] : a bog manganese containing copper and often cobalt oxides

lam·pa·ra \'lampərə\ *or* **lampara net** *n* -s [prob. fr. Sp *lámpara*, lit., lamp, fr. OSp *lámpada*, fr. L *lampad-, lampas* — more at LAMP] : a fishing net that somewhat resembles a purse seine and is used esp. for taking bait fishes

¹lam·pas \'lampəs\ *n* -ES [ME *lawmpas*, a kind of glossy crape, fr. MD *lampers* — more at LAMBREQUIN] : a brocaded fabric of silk and rayon or cotton having jacquard-woven designs in two or more colors and used chiefly for upholstery

²lampas \", -pəz\ *n* -ES [MF, fr. OF] : a congestion of the mucous membrane of the hard palate just posterior to the incisor teeth of the horse due to irritation and bruising from harsh coarse feeds

lam·pat·ia \lam'pad·ēə\ *n* -s [Nepali *lāmpatiyā*, fr. *lām* long (fr. Skt *lamba* pendent, long, fr. *lambate* it hangs down) + *pāt* leaf, fr. Skt *pattra* wing, feather, leaf; akin to Skt *patati* he flies, falls — more at FEATHER, LIMP] : KOKAN

¹lampblack \'ˌ,ˌ\ *n* [*¹lamp* + *black*] **1** : a fine bulky black soot deposited (as from the flame of a smoking oil lamp) in incomplete combustion of carbonaceous materials; *esp* : a soot obtained by burning liquid hydrocarbons (as creosote oil or petroleum fuel oils) that is characterized by a duller less intense black than channel black and other carbon blacks, by a blue undertone, and by a content of varying amounts of oily matter in addition to carbon and that is used chiefly as a pigment (as in paints, enamels, printing inks, and concrete) and as a source of carbon for electric brushes — usu. distinguished from *carbon black* **2** : a nearly neutral slightly bluish black that is darker and slightly greener than Quaker blue

²lampblack \"\ *vt* : to cover, coat, or smear with lampblack : blacken with lampblack ⟨~*ed* platinum —Agnes M. Clerke⟩

lampbrush chromosome \'ˌ,ˌ\ *n* [trans. of G *lampenbürstenchromosom*] : a greatly enlarged pachytene chromo-

McGraw-Hill Dictionary of Scientific and Technical Terms

Fifth Edition

Sybil P. Parker
Editor in Chief

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must be released from an aircraft in order to hit a target. { 'bäm ˌsīt }

bomb test [ENG] A leak-testing technique in which the vessel to be tested is immersed in a pressurized fluid which will be driven through any leaks present. { 'bäm ˌtest }

Bombycidae [INV ZOO] A family of lepidopteran insects of the superorder Heteroneura that includes only the silkworms. { bäm'bis·əˌdē }

Bombyliidae [INV ZOO] The bee flies, a family of dipteran insects in the suborder Orthorrhapha. { ˌbäm·bə'lī·əˌdē }

Bombyx [INV ZOO] The type genus of Bombycidae. { 'bämˌbiks }

Bombyx mori [INV ZOO] The commercial silkworm. { 'bämˌbiks 'mȯrē }

bond [CHEM] The strong attractive force that holds together atoms in molecules and crystalline salts. Also known as chemical bond. [CIV ENG] A piece of building material that serves to unite or bond, such as an arrangement of masonry units. [ELEC] The connection made by bonding electrically. [ENG] **1.** A wire rope that fixes loads to a crane hook. **2.** Adhesion between cement or concrete and masonry or reinforcement. [MET] **1.** Material added to molding sand to impart bond strength. **2.** Junction of the base metal and filler metal, or the base metal beads, in a welded joint. { bänd }

Bond albedo [OPTICS] The fraction of the total incident light that is reflected by a spherical body. { 'bänd alˌbē·dō }

Bond and Wang theory [MECH ENG] A theory of crushing and grinding from which the energy, in horsepower-hours, required to crush a short ton of material is derived. { ˌbänd ən 'waŋ ˌthē·ə·rē }

bond angle [PHYS CHEM] The angle between bonds sharing a common atom. Also known as valence angle. { 'bänd ˌaŋ·gəl }

bond blister [MET] An unbonded area at the interface between the coating and the metal core of a cladded surface. { 'bänd ˌblis·tər }

bond clay [MATER] A type of clay with high plasticity and high dry strength used to bond nonplastic materials; may be refractory. { 'bänd ˌklā }

bond coat [MATER] **1.** A coat of bonding agent or plaster applied to a surface to provide a bond for succeeding coats of plaster. **2.** A coat of primer applied to a surface to act as a sealer or to ensure adhesion of paint to the surface. { 'bänd ˌkōt }

bond course [BUILD] A course of headers to bond the facing masonry to the backing masonry. { 'bänd ˌkȯrs }

bond dissociation energy [PHYS CHEM] The change in enthalpy that occurs with the homolytic cleavage of a chemical bond under conditions of standard state. { ˌbänd di,sō·sē'ā·shən 'en·ər·jē }

bond distance [PHYS CHEM] The distance separating the two nuclei of two atoms bonded to each other in a molecule. Also known as bond length. { 'bänd ˌdis·təns }

bonded coating [MATER] A finishing or protecting layer of any compound affixed to a surface. { 'bän·dəd ˌkōd·iŋ }

bonded NR diode [ELECTR] An n^+ junction semiconductor device in which the negative resistance arises from a combination of avalanche breakdown and conductivity modulation which is due to the current flow through the junction. { 'bän·dəd ˌen'är 'dīˌōd }

bonded-phase chromatography [ANALY CHEM] A type of high-pressure liquid chromatography which employs a stable, chemically bonded stationary phase. { 'bän·dəd ˌfāz ˌkrō·mə'täg·rə·fē }

bonded strain gage [ENG] A strain gage in which the resistance element is a fine wire, usually in zigzag form, embedded in an insulating backing material, such as impregnated paper or plastic, which is cemented to the pressure-sensing element. { 'bän·dəd 'strān ˌgāj }

bonded transducer [ENG] A transducer which employs a bonded strain gage for sensing pressure. { 'bän·dəd tranz'dü·sər }

bond energy [PHYS CHEM] **1.** The average value of specific bond dissociation energies that have been measured from different molecules of a given type. **2.** *See* average bond association energy. { 'bänd ˌen·ər·jē }

bonder *See* bondstone. { 'bän·dər }

bonderize [MET] To coat steel with a solution of phosphates for corrosion protection. { 'bän·dəˌrīz }

bond header [BUILD] In masonry, a stone that extends the full thickness of the wall. Also known as throughstone. { 'bänd ˌhed·ər }

bond hybridization [CHEM] The linear combination of two or more simple atomic orbitals. { 'bänd ˌhī·brəd·ə'zā·shən }

bonding [CHEM] The joining together of atoms to form molecules or crystalline salts. [ELEC] The use of low-resistance material to connect electrically a chassis, metal shield cans, cable shielding braid, and other supposedly equipotential points to eliminate undesirable electrical interaction resulting from high-impedance paths between them. [ENG] **1.** The fastening together of two components of a device by means of adhesives, as in anchoring the copper foil of printed wiring to an insulating baseboard. **2.** *See* cladding. [PSYCH] The formation of an emotional attachment between two people whose identities are significantly affected by their mutual interactions. [TEXT] The joining of two fabrics, usually a face fabric and a lining fabric. { 'bän·diŋ }

bonding agent [MATER] Any substance that fixes one material to another. { 'bän·diŋ ˌā·jənt }

bonding electron [PHYS CHEM] An electron whose orbit spans the entire molecule and so assists in holding it together. { 'bän·diŋ i'lekˌträn }

bonding orbital [PHYS CHEM] A molecular orbital formed by a bonding electron whose energy decreases as the nuclei are brought closer together, resulting in a net attraction and chemical bonding. { 'bän·diŋ 'ȯr·bəd·əl }

bonding pad [ELECTR] A metallized area on the surface of a semiconductor device, to which connections can be made. { 'bän·diŋ ˌpad }

bonding strength [MECH] Structural effectiveness of adhesives, welds, solders, glues, or of the chemical bond formed between the metallic and ceramic components of a cermet, when subjected to stress loading, for example, shear, tension, or compression. { 'bän·diŋ ˌstreŋkth }

bonding wire [ELEC] Wire used to connect metal objects so they have the same potential (usually ground potential). { 'bän·diŋ ˌwīr }

bond length *See* bond distance. { 'bänd ˌleŋkth }

bond-line formula [ORG CHEM] A representation of a molecule in which bonds are represented by lines, carbon atoms are represented by line ends and intersections, and atoms other than hydrogen and carbon are represented by their elemental symbols, as is hydrogen when it is bonded to an atom other than hydrogen or carbon. Also known as carbon-skeleton formula; line-segment formula. { 'bändˌlīn ˌfȯr·myə·lə }

bond migration [CHEM] The movement of a bond to a different position within the same molecular entity. { 'bänd mī,grā·shən }

bond moment [PHYS CHEM] The degree of polarity of a chemical bond as calculated from the value of the force of the response of the bond when the bond is subjected to an electric field. { 'bänd ˌmō·mənt }

Bond number [FL MECH] A dimensionless number used in the study of atomization and the study of bubbles and drops, equal to $(\rho - \rho')L^2g/\sigma$, where ρ is the density of a bubble or drop, ρ' is the density of the surrounding medium, L is a characteristic dimension, g is the acceleration of gravity, and σ is the surface tension of the bubble or drop. { 'bänd ˌnəm·bər }

bond orientational order [PHYS] An ordering of atoms or molecules in an intermediate state of condensed matter in which the atoms or molecules are distributed at random, as in a fluid or glass, but the condensed matter is orientationally anisotropic on a macroscopic scale. { ˌbänd ˌȯr·ē·ən'tā·shən·əl 'ȯrd·ər }

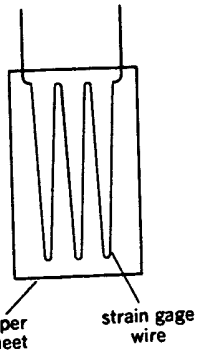
bond paper [MATER] A paper used for writing paper, business forms, and typewriter paper; the less expensive bond papers are made from wood sulfite pulps; rag-content bonds contain 25, 50, 75, or 100% of pulp made from rags, and offer greater permanence and strength. { 'bänd ˌpā·pər }

Bond's law [MECH ENG] A statement that relates the work required for the crushing of solid materials (for example, rocks and ore) to the product size and surface area and the lengths of cracks formed. Also known as Bond's third theory. { 'bänz 'lȯ }

Bond's third theory *See* Bond's law. { 'bänz ˌthərd 'thē·ə·rē }

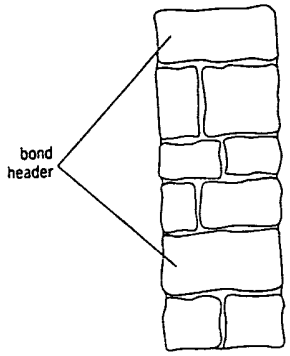
bondstone [BUILD] A stone joining the coping above a gable to the wall. [CIV ENG] A masonry stone set with its longest dimension perpendicular to the wall face to bind the wall together. Also known as bonder. { 'bändˌstōn }

BONDED STRAIN GAGE



Elements of a bonded strain gage.

BOND HEADER



A masonry section showing bond headers.

conformal chart or plotting sheet; approximates a great-circle bearing. { 'lam·bərt ,ber·iŋ }

Lambert-Beer law *See* Bouguer-Lambert-Beer law. { 'lam·bərt 'bir ,lȯ }

Lambert conformal chart [MAP] A chart on the Lambert conformal projection. { 'lam·bərt kən'fȯr·məl ,chärt }

Lambert conformal projection [MAP] A conformal conic projection with two standard parallels, or a conformal conic map projection in which the surface of a sphere or spheroid, such as the earth, is conceived as developed on a cone which intersects the sphere or spheroid at two standard parallels; the cone is then spread out to form a plane which is the map. { 'lam·bərt kən'fȯr·məl prə'jek·shən }

Lambert course [NAV] Course as measured on a Lambert conformal chart or plotting sheet. { 'lam·bərt ,kȯrs }

Lambert's law [OPTICS] **1.** The law that the illumination of a surface by a light ray varies as the cosine of the angle of incidence between the normal to the surface and the incident ray. **2.** The law that the luminous intensity in a given direction radiated or reflected by a perfectly diffusing plane surface varies as the cosine of the angle between that direction and the normal to the surface. **3.** *See* Bouguer-Lambert law. { 'lam·bərts ,lȯ }

Lambert surface [THERMO] An ideal, perfectly diffusing surface for which the intensity of reflected radiation is independent of direction. { 'lam·bərt ,sər·fəs }

lambing storm [METEOROL] A slight fall of snow in the spring in England. Also known as lamb-blasts; lamb-showers; lamb-storm. { 'lam·iŋ ,stȯrm }

Lamb shift [ATOM PHYS] A small shift in the energy levels of a hydrogen atom, and of hydrogenlike ions, from those predicted by the Dirac electron theory, in accord with principles of quantum electrodynamics. { 'lam ,shift }

Lamb-shift source [NUCLEO] A device for producing a beam of polarized ions from one-electron atoms in their 2*s* excited state; the 2*s* and 2*p* levels, initially separated by the Lamb shift, are mixed by magnetic and electric fields, and selected nuclear magnetic substrates are then depopulated, leaving the remaining atoms in a state with large nuclear polarization. { 'lam ,shift ,sȯrs }

lamb-showers *See* lambing storm. { 'lam ,shau·ərz }

lamb-storm *See* lambing storm. { 'lam,stȯrm }

lamb's wool [VERT ZOO] The first fleece taken from a sheep up to 7 months old, having natural tapered fiber tip and spinning qualities superior to those of wool taken from previously shorn sheep. { 'lamz ,wu̇l }

Lamb wave [ACOUS] *See* plate wave. [ELECTROMAG] Electromagnetic wave propagated over the surface of a solid whose thickness is comparable to the wavelength of the wave. { 'lam ,wāv }

lamé [TEXT] A fabric, usually of silk, rayon, or polyester, ornamented with flat metal threads. { la'mā }

Lamé constants [MECH] Two constants which relate stress to strain in an isotropic, elastic material. { lä'mā ,kän·stənts }

Lamé functions [MATH] Functions that arise when Laplace's equation is separated in ellipsoidal coordinates. { lä'mā ,fəŋk·shənz }

lamella [ANAT] A thin scale or plate. [CIV ENG] A thin member made of reinforced concrete, metal, or wood that is joined with similar members in an overlapping pattern to form an arch or a vault. { lə'mel·ə }

lamella arch [CIV ENG] An arch consisting basically of a series of intersecting skewed arches made up of relatively short straight members; two members are bolted, riveted, or welded to a third piece at its center. { lə'mel·ə ,ärch }

lamellar bone [HISTOL] Any bone with a microscopic structure consisting of thin layers or plates. { lə'mel·ər ,bōn }

lamellar chloroplast [CYTOL] A type of chloroplast in which the layered structure extends more or less uniformly through the whole chloroplast body. { lə'mel·ər 'klȯr·ə,plast }

lamellar crystal [CRYSTAL] A polycrystalline substance whose grains are in the form of thin sheets. { lə'mel·ər 'krist·əl }

lamella roof [BUILD] A large span vault built of members connected in a diamond pattern. { lə'mel·ə ,rüf }

lamellar vector field *See* irrotational vector field. { lə'mel·ər 'vek·tər ,fēld }

Lamellibranchiata [INV ZOO] An equivalent name for Bivalvia. { lə,mel·ə,braŋ·kē'äd·ə }

Lamellisabellidae [INV ZOO] A family of marine animals in the order Thecanephria. { lə,mel·ə·sə'bel·ə,dē }

Lamé polynomials [MATH] Polynomials which result when certain parameters of Lamé functions assume integral values, and which are used to express physical solutions of Laplace's equation in ellipsoidal coordinates. { lä'mā ,päl·ə'nō·mē·əlz }

Lamé's equations [MATH] A general collection of second-order differential equations which have five regular singularities. { lä'māz i,kwā·zhənz }

Lamé's relations [MATH] Six independent relations which when satisfied by the covariant metric tensor of a three-dimensional space provide necessary and sufficient conditions for the space to be euclidean. { lä'māz ri,lā·shənz }

Lamé wave functions [MATH] Functions which arise when the wave equation is separated in ellipsoidal coordinates. Also known as ellipsoidal wave functions. { lä'mā 'wāv ,fəŋk·shənz }

Lamiaceae [BOT] An equivalent name for Labiatae. { ,lā·mē'ās·ē,ē }

Lamiales [BOT] An order of dicotyledonous plants in the subclass Asteridae marked by its characteristic gynoecium, consisting of usually two biovulate carpels, with each carpel divided between the ovules by a false partition, or with the two halves of the carpel seemingly wholly separate. { ,lā·mē'ā·lēz }

lamina [BOT] *See* blade. [ANAT] A thin sheet or layer of tissue; a scalelike structure. [GEOL] A thin, clearly differentiated layer of sedimentary rock or sediment, usually less than 1 centimeter thick. [MATER] A flat or curved arrangement of unidirectional or woven fibers in a matrix. { 'lam·ə·nə }

lamina cribrosa [ANAT] **1.** The portion of the sclera which is perforated for the passage of the optic nerve. **2.** The fascia covering the saphenous opening in the thigh. **3.** The anterior or posterior perforated space of the brain. **4.** The perforated plates of bone through which pass branches of the cochlear part of the vestibulocochlear nerve. { 'lam·ə·nə krə'brō·sə }

laminal placentation [BOT] Condition in which the ovules occur on the inner surface of the carpels. { 'lam·ən·əl ,plas·ən'tā·shən }

laminar [SCI TECH] **1.** Arranged in thin layers. **2.** Pertaining to viscous streamline flow without turbulence. { 'lam·ə·nər }

laminar boundary layer [FL MECH] A thin layer over the surface of a body immersed in a fluid, in which the fluid velocity relative to the surface increases rapidly with distance from the surface and the flow is laminar. { 'lam·ə·nər 'baun·drē ,lā·ər }

laminar composite [MATER] A composite material that consists of two or more layers of different materials that are bonded together. { 'lam·ə·nər kəm'päz·ət }

laminar flow [FL MECH] Streamline flow of an incompressible, viscous Newtonian fluid; all particles of the fluid move in distinct and separate lines. { 'lam·ə·nər 'flō }

laminar flow control [AERO ENG] The removal of a small amount of boundary-layer air from the surface of an aircraft wing with the result that the airflow is laminar rather than turbulent; frictional drag is greatly reduced. { 'lam·ə·nər 'flō kən,trōl }

Laminariales [BOT] An order of brown, large, structurally complicated, often highly differentiated members, commonly called kelps, of the algal class Phaeophyceae; distinctive features include a life history in which microscopic, filamentous, dioecious gametophytes alternate with a massive, parenchymatous sporophyte, and a mature sporophyte typically consisting of a holdfast, stipe, and one or more blades. { ,lam·ə,nar·ē'ā·lēz }

Laminariophyceae [BOT] A class of algae belonging to the division Phaeophyta. { ,lam·i,nar·ē·ō'fīs·ē,ē }

laminar sublayer [FL MECH] The laminar boundary layer underlying a turbulent boundary layer. { 'lam·ə·nər 'səb,lā·ər }

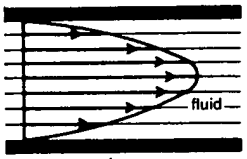
laminar wing [AERO ENG] A low-drag wing in which the distribution of thickness along the chord is so selected as to maintain laminar flow over as much of the wing surface as possible. { 'lam·ə·nər 'wiŋ }

laminate [MATER] A sheet of material made of several different bonded layers. { 'lam·ə,nāt }

laminated composite [MATER] A composite material consisting of layers of various materials. { 'lam·ə,nād·əd kəm'päz·ət }

laminated contact [ELEC] Switch contact made up of a number of laminations, each making individual contact with the opposite conducting surface. { 'lam·ə,nād·əd 'kän,takt }

LAMINAR FLOW



Laminar flow in a circular pipe. In this case the velocity adjacent to the wall is zero and increases to a maximum in the center of the pipe.

ENGINEERED MATERIALS HANDBOOK™

Volume 1

COMPOSITES

Prepared under the direction of the
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impart heat and light stability, weathering resistance, color, and migration resistance to plastics.

insert. An integral part of a plastic molding consisting of metal or other material that may be molded or pressed into position after the molding is completed.

insulation resistance. The electrical resistance between two conductors or systems of conductors separated only by insulating material. The ratio of the applied voltage to the total current between two electrodes in contact with a specified insulator. The electrical resistance of an insulating material to a direct voltage.

insulator. A material of such low electrical conductivity that the flow of current through it can usually be neglected. Similarly, a material of low thermal conductivity, such as that used to insulate structural shells.

integral composite structure. Composite structure in which several structural elements, which would conventionally be assembled together by bonding or mechanical fasteners after separate fabrication, are instead laid up and cured as a single, complex, continuous structure, for example, spars, ribs, and one stiffened cover of a wing box fabricated as a single integral part. The term is sometimes applied more loosely to any composite structure not assembled by mechanical fasteners. All or some parts of the assembly may be co-cured.

integrally heated. A term referring to tooling that is self-heating, through use of electrical heaters such as cal rods. Most hydroclave tooling is integrally heated. Some autoclave tooling is integrally heated to compensate for thick sections, to provide high heat-up rates, or to permit processing at a higher temperature than is otherwise possible with the autoclave.

integral skin foam. Urethane foam with a cellular core structure and a relatively nonporous skin.

interface. The boundary or surface between two different, physically distinguishable media. On fibers, the contact area between fibers and sizing or finish. In a laminate, the contact area between the reinforcement and the laminating resin.

interference fits. A joint or mating of two parts in which the male part has an external dimension larger than the internal dimension of the mating female part. Distension of the female by the male creates a stress, which supplies the bonding force for the joint.

interlaminar. Descriptive term pertaining to an object (for example, voids), event (for example, fracture), or potential field (for example, shear stress) referenced as existing or occurring between two or more adjacent laminae.

interlaminar shear. Shearing force tending to produce a relative displacement between two laminae in a laminate along the plane of their interface.

intermediate temperature setting adhesive. An adhesive that sets in the temperature range from 30 to 100 °C (87 to 211 °F).

interphase. The boundary region between a bulk resin or polymer and an adherend in which the polymer has a high degree of orientation to the adherend on a molecular basis. It plays a major role in the load transfer process between the bulk of the adhesive and the adherend or the fiber and the laminate matrix resin.

interply hybrid. A composite in which adjacent laminae are composed of different materials.

intralaminar. Descriptive term pertaining to an object (for example, voids), event (for example, fracture), or potential field (for example, temperature gradient) existing entirely within a single lamina without reference to any adjacent laminae.

intraply hybrid. A composite in which different materials are used within a specific layer or band.

irradiation. As applied to plastics, the bombardment with a variety of subatomic particles, usually alpha-, beta-, or gamma-rays. Used to initiate polymerization and copolymerization of plastics and in some cases to bring about changes in the physical properties of a plastic.

irreversible. Not capable of redissolving or remelting. Chemical reactions that proceed in a single direction and are not capable of reversal (as applied to thermosetting resins).

isocyanate plastics. Plastics based on resins made by the condensation of organic isocyanates with other compounds. Generally reacted with polyols on a polyester or polyether backbone molecule, with the reactants being joined through the formation of the urethane linkage. See also *polyurethane* and *urethane plastics*.

isostatic pressing. Pressing powder under a gas or liquid so that pressure is transmitted equally in all directions, for example, in sintering.

isotropic. Having uniform properties in all directions. The measured properties of an isotropic material are independent of the axis of testing.

Izod impact test. A test for shock loading in which a notched specimen bar is held at one end and broken by striking, and the energy absorbed is measured.

J

joint, adhesive. See *adhesive joint*.

joint, butt. See *butt joint*.

joint, edge. See *edge joint*.

joint, lap. See *lap joint*.

joint, scarf. See *scarf joint*.

K

kerf. The width of a cut made by a saw blade, torch, water jet, laser beam, and so forth.

Kevlar. An organic polymer composed of aromatic polyamides having a para-type orientation (parallel chain extending bonds from each aromatic nucleus).

knitted fabrics. Fabrics produced by interlooping chains of yarn.

K factor. The coefficient of thermal conductivity. The amount of heat that passes through a unit cube of material in a given time when the difference in temperature of two opposite faces is 1°.

knuckle area. The area of transition between sections of different geometry in a filament-wound part, for example, where the skirt joins the cylinder of the pressure vessel. Also called Y-joint.

L

lamina. A single ply or layer in a laminate made up of a series of layers (organic composite). A flat or curved surface containing unidirectional fibers or woven fibers embedded in a matrix (metal matrix composite).

laminae. Plural of lamina.

laminate. To unite laminae with a bonding material, usually with pressure and heat (normally used with reference to flat sheets, but also rods and tubes). A product made by such bonding. See also *bidirectional laminate* and *unidirectional laminate*.

laminate coordinates. A reference coordinate system (used to describe the properties of a laminate), generally in the direction of principal axes, when they exist.

laminate orientation. The configuration of a cross-plied composite laminate with regard to the angles of cross-plying, the number of laminae at each angle, and the exact sequence of the lamina lay-up.

laminate ply. One fabric-resin or fiber-resin layer of a product that is bonded to adjacent layers in the curing process.

lap. In filament winding, the amount of overlay between successive windings, usually intended to minimize gapping. In bonding, the distance one adherend covers another adherend.

lap joint. A joint made by placing one adherend partly over another and bonding the overlapped portions.

lattice pattern. A pattern of filament winding with a fixed arrangement of open voids.

lay-up. The reinforcing material placed in position in the mold. The process of placing the